Woody mulch effects
on soil climate & N availability
in mechanical fuel reduction treatments

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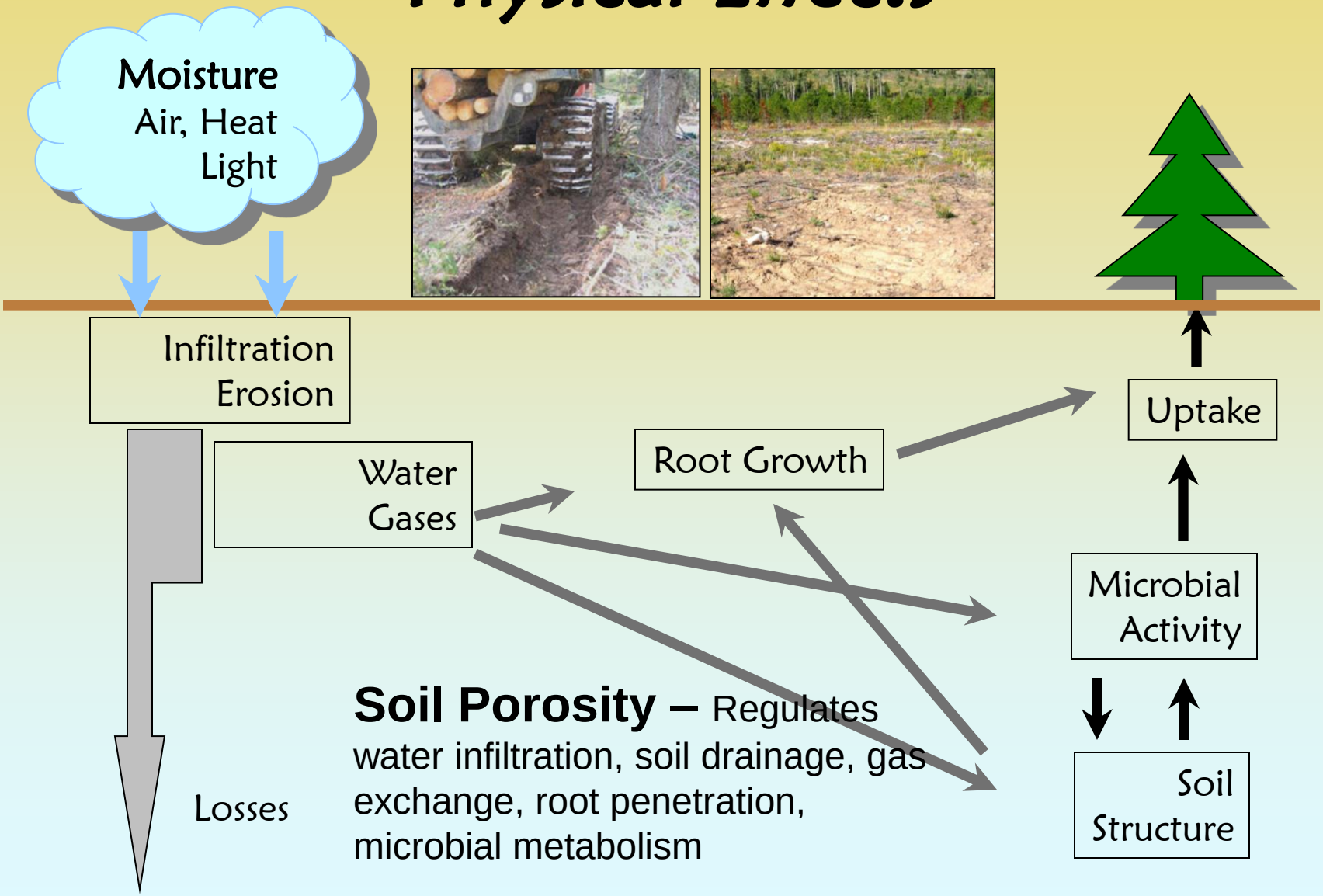
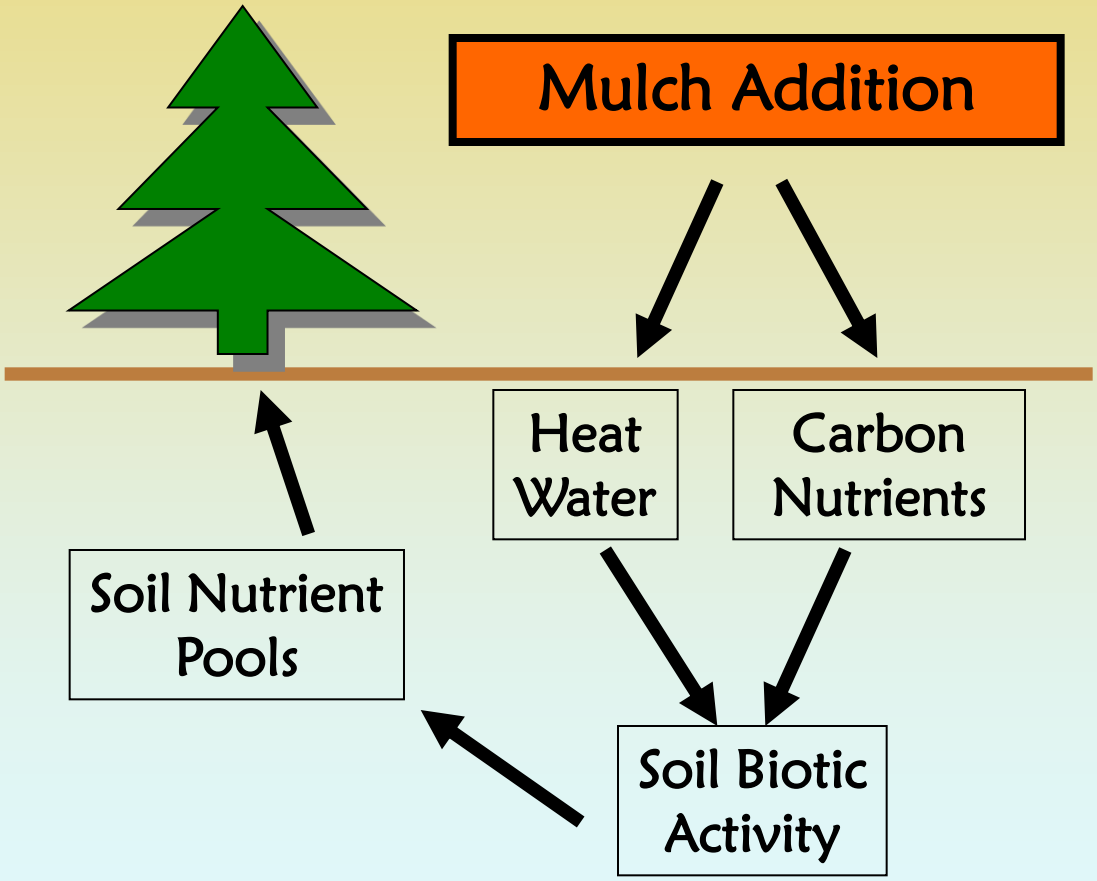
Management Effects on Soil
Physical Effects



Mulching = Physical + Biological Effects



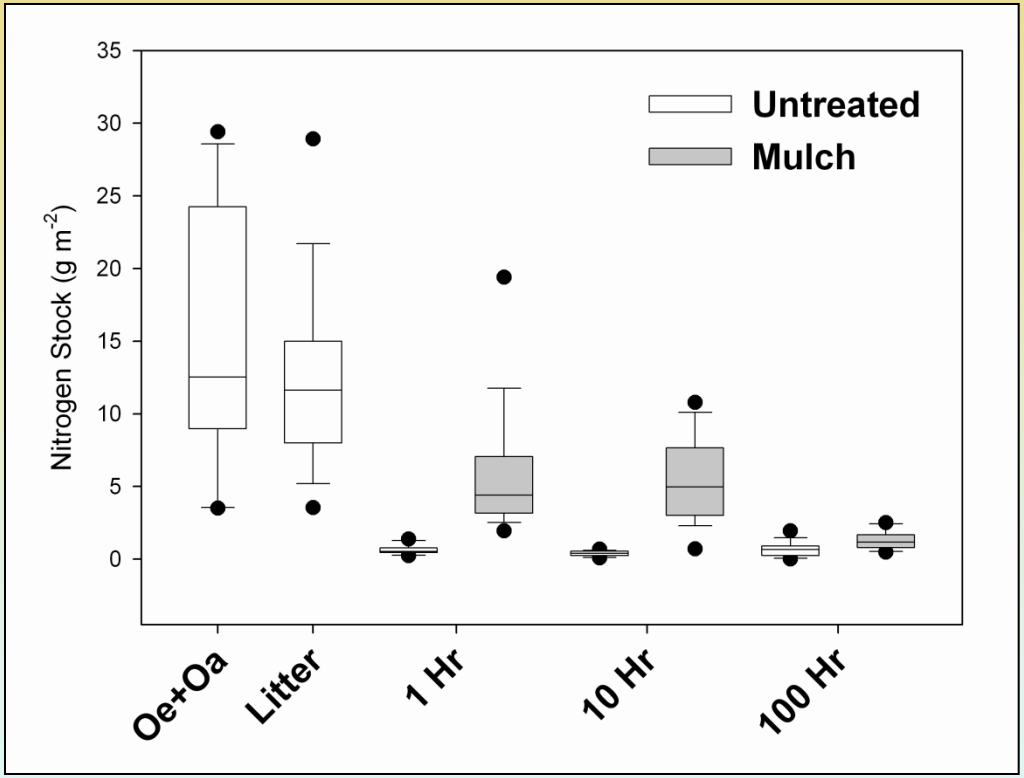
Talk Outline

1. How much N is added with mulch?
2. Effects on soil temperature & moisture
3. Effects on plant available soil nitrogen
4. Do Effects Change with Mulch Depth?
5. Other Stuff

Why *Anyone* Might Care….

- Treatment Longevity
- Site & Soil Productivity
- Native/Non-Native Species, etc…..

N Addition in Mulch



Mulching increases the total mass of the forest floor up to 3-fold

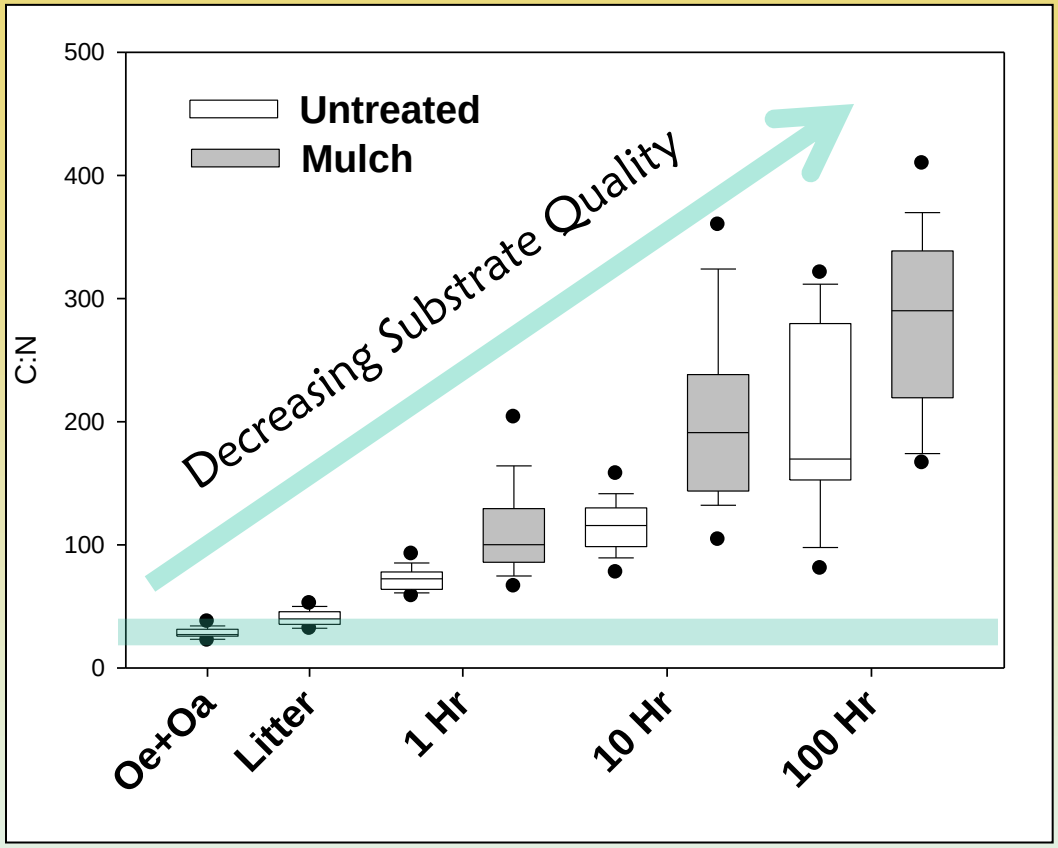
~10-fold increase in N contained in 1, 10 and 100 hr size material.

N added < half that contained in untreated forest floor

Nitrogen applied with mulch is

10-20 times annual N deposition

(10 g / m^2 = 100 kg N / ha)



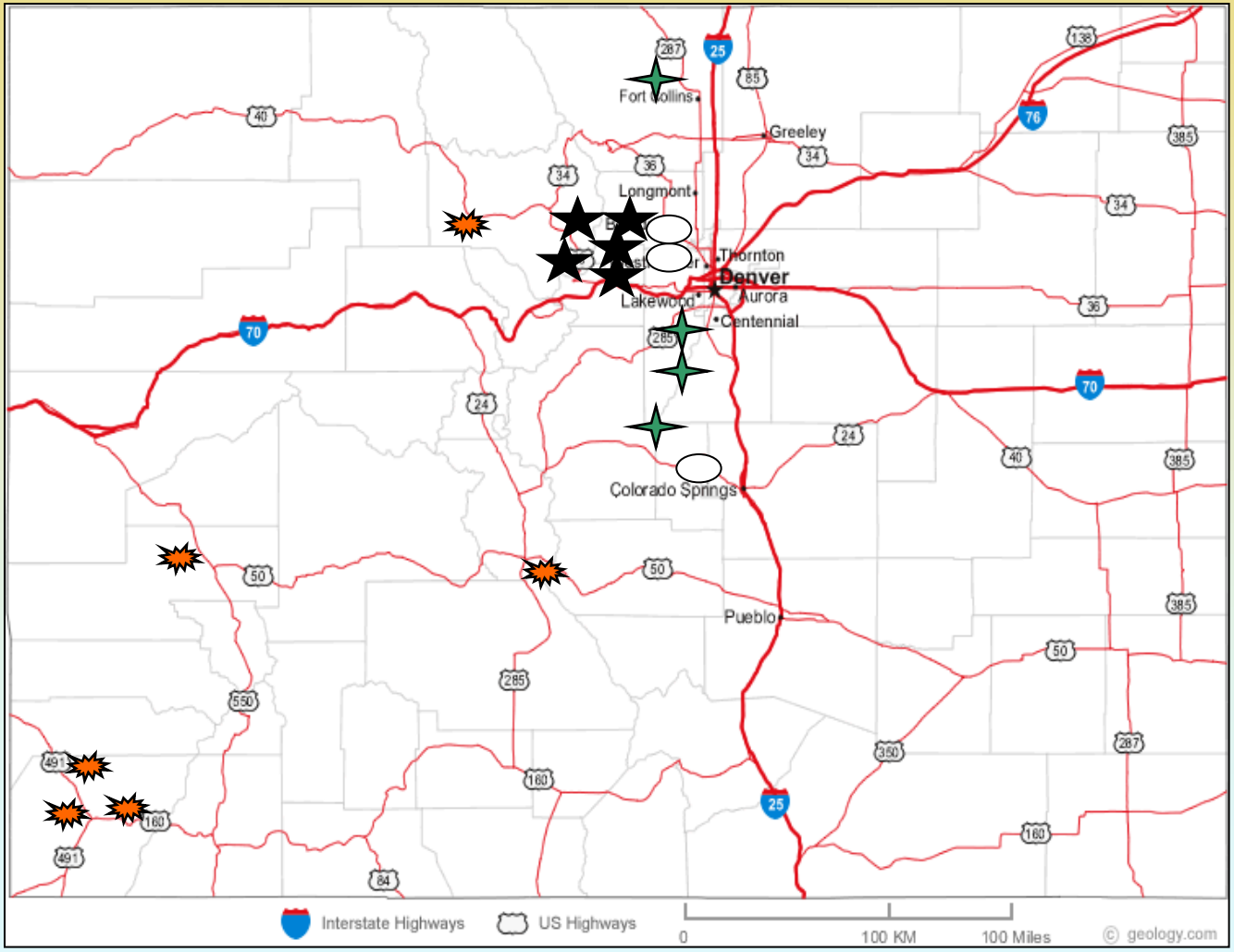
C:N increases from forest floor & litter (26, 38) to the 1,10 and 100 hr fuel size classes.

C:N of newly applied mulch is ~ 1.5-fold higher than the comparable untreated size classes.

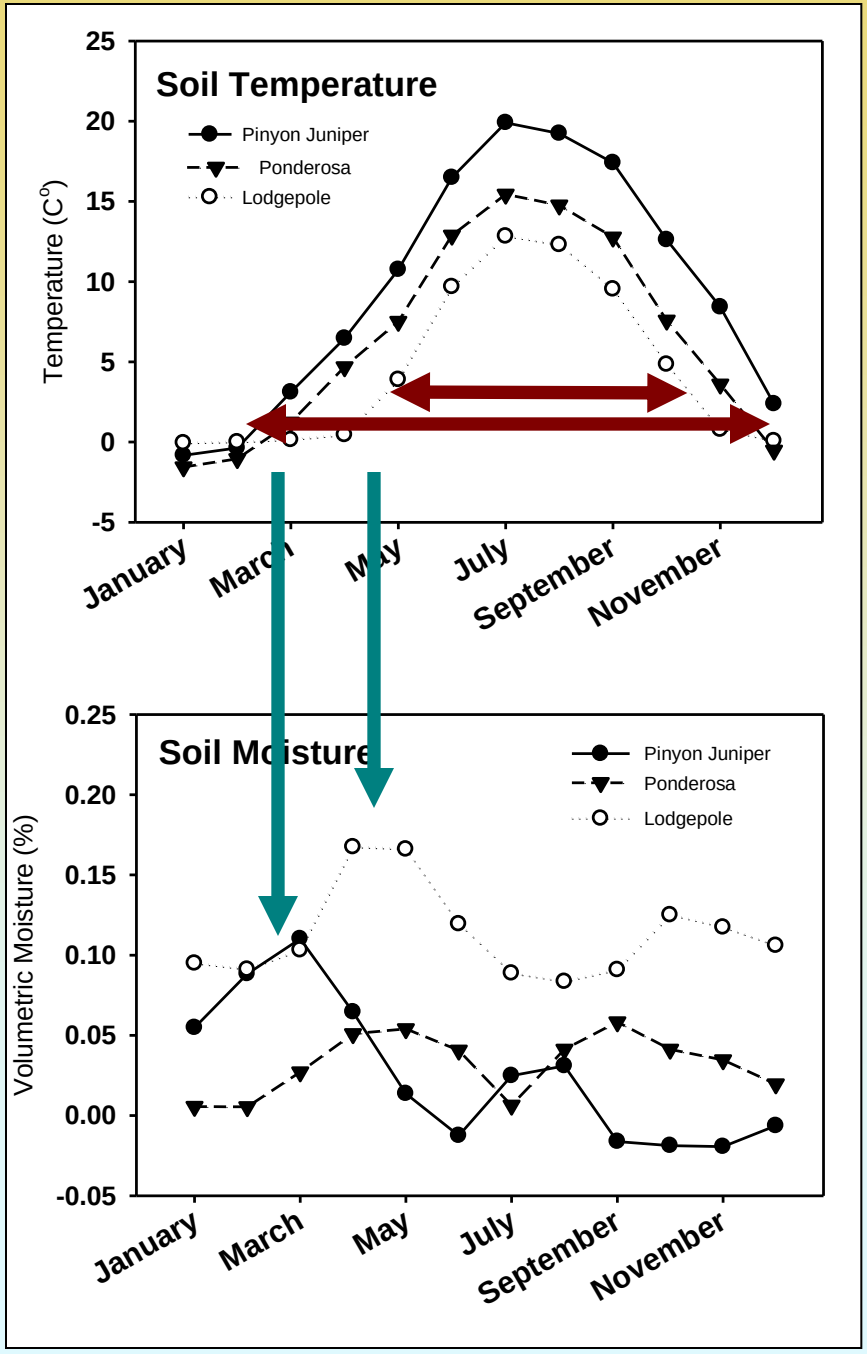
Mulch is a source of C that stimulates microbial growth and uptake of soil N.

Added mulch will remain a sink for N until its C:N ratio reaches that of the forest floor.

Management Areas



- Pinyon-Juniper
- Ponderosa pine / Douglas fir
- Mixed conifer
- Lodgepole pine



Mean Annual Temp

Pinyon	50 °F
Ponderosa	43
Lodgepole	37

Mean Summer

Pinyon	68
Ponderosa	61
Lodgepole	55

Mean Winter

Pinyon	27
Ponderosa	28
Lodgepole	16

Growing season length and moisture patterns differ among ecosystems

Study Details – Soil N Availability

Operational Comparison

Paired Mulched *vs* Untreated units

18 areas – 4 Ecosystems

3 transects (50-m) per study area

20 quadrats (1-m^2) per transect

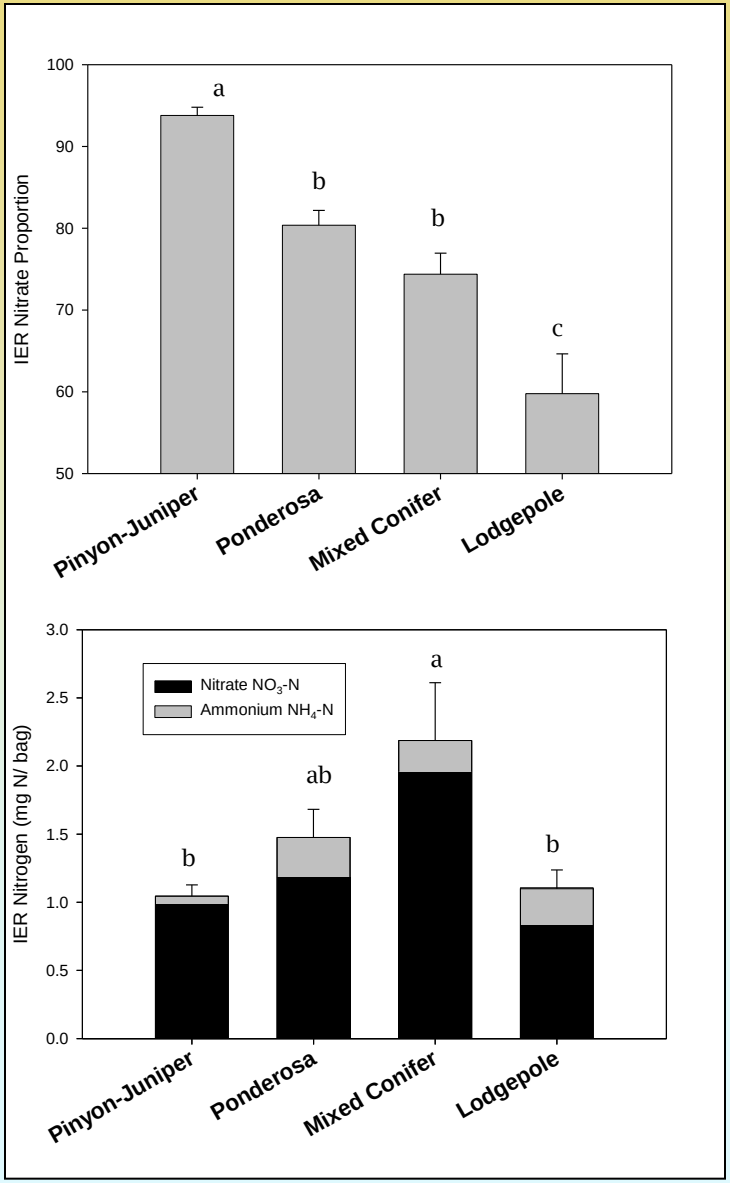
Experimental Manipulation

	Shallow	*vs.*	Deep Mulch
PJ	1”		3”
Ponderosa	3”		6”
Mixed Con	“		“
Lodgepole	“		“

Soil N Availability

Ion Exchange Resins (1 yr assay)

Soil N –Availability to Plants



Two N Forms Measured

NH_4^+ Ammonium

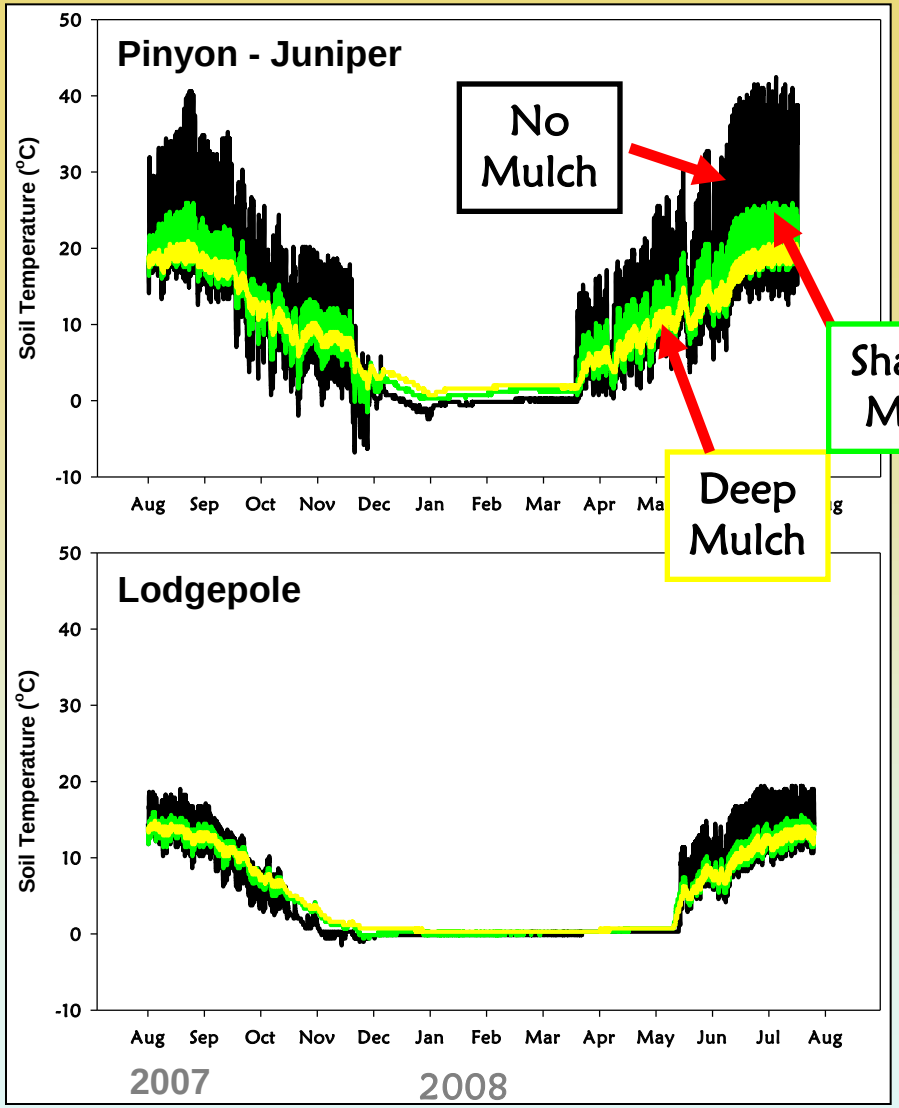
NO_3^- Nitrate

Nitrate is more mobile … dominant N form

… tracks soil pH

PJ & LPP lowest total N availability

Soil N … good or bad?



Soil Temperature

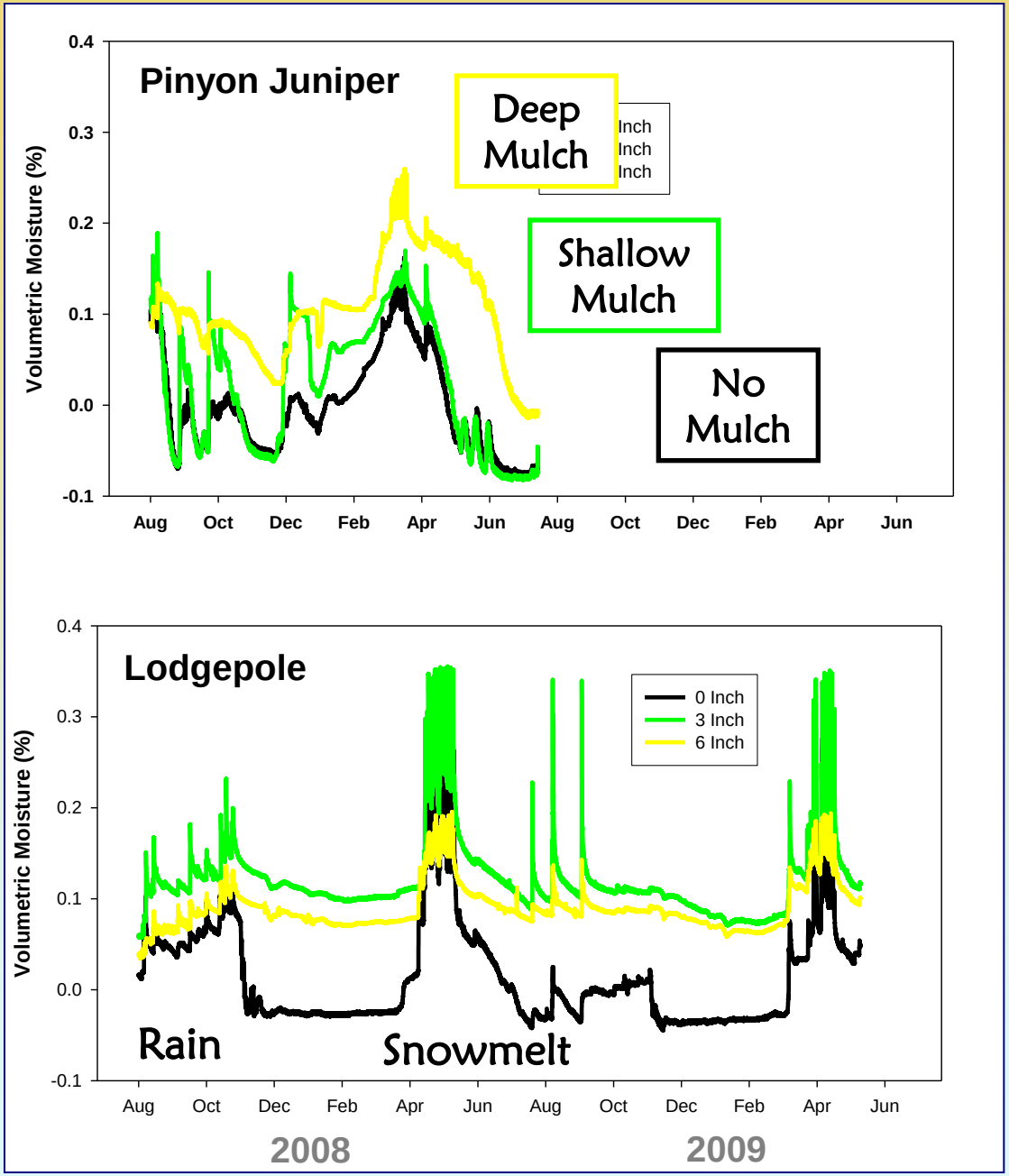
Cooler mean & max summer temp's

Summer Months

PJ	Shallow	Deep	
Mean	5.6	8.3	Cooler (°C)
Max	29.7	38.7	Cooler
Min	6.6	7.6	Warmer

LPP	Shallow	Deep	
Mean	1.8	2.2	Cooler
Max	6.8	9.5	Cooler
Min	7.4	9.5	Warmer

… also warmer minimum & warmer winter temperatures



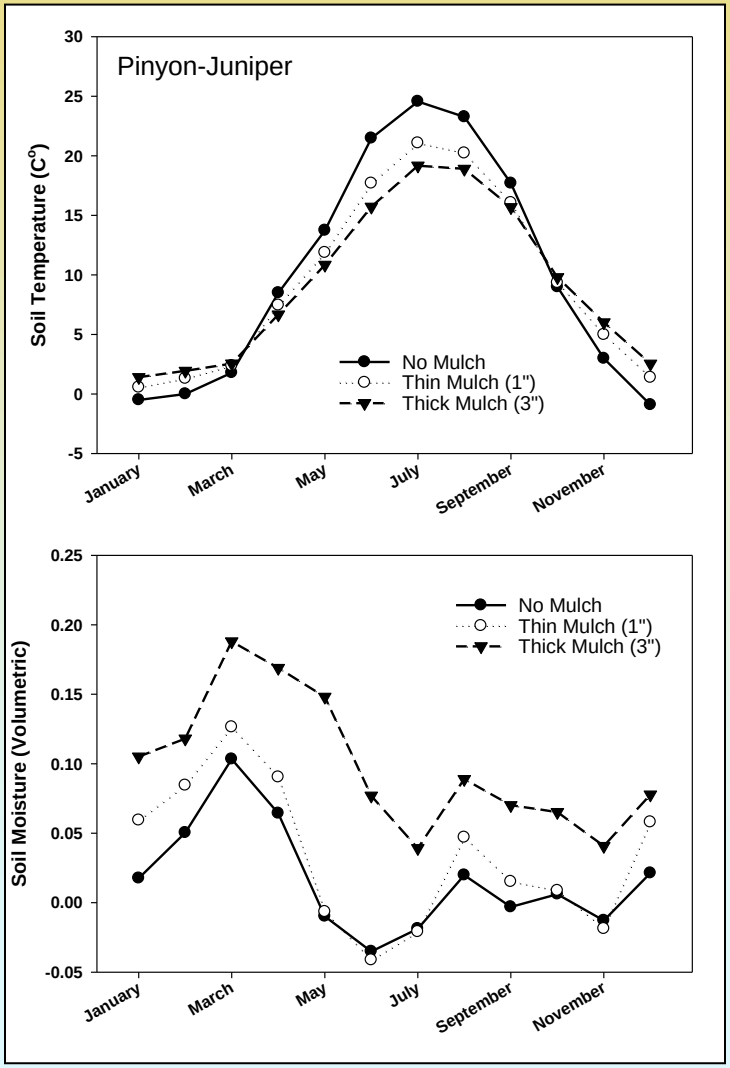
Soil Moisture

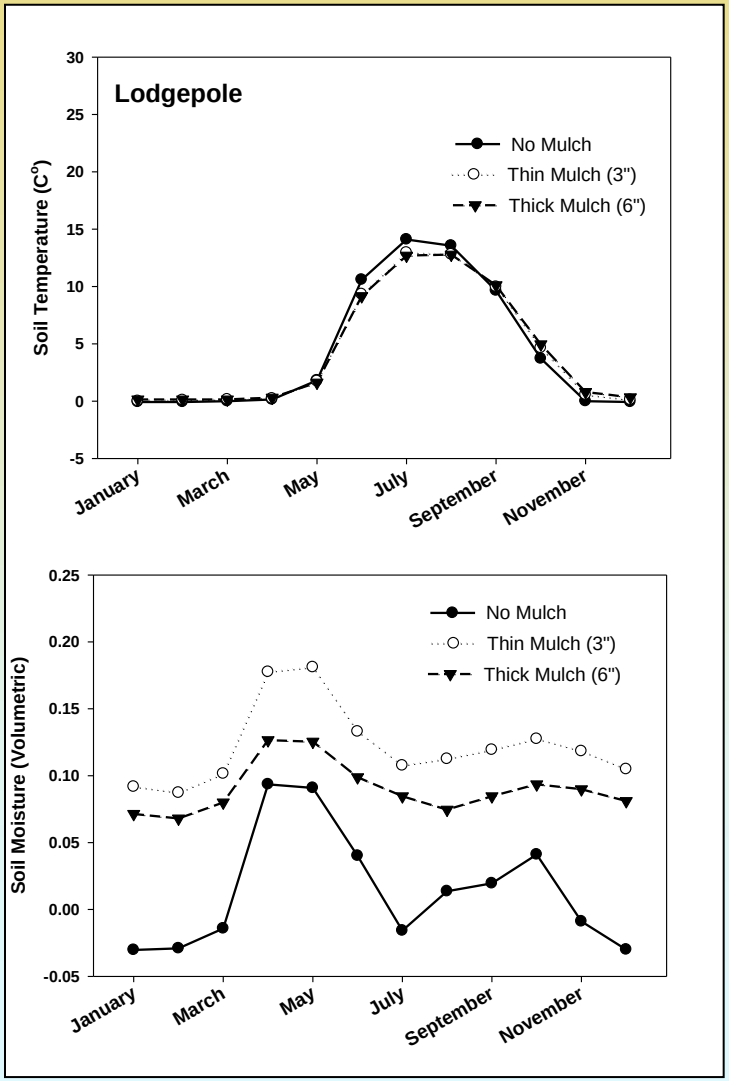
Mulched plots moister year-round

Respond to summer rain

Not intercepting ppt

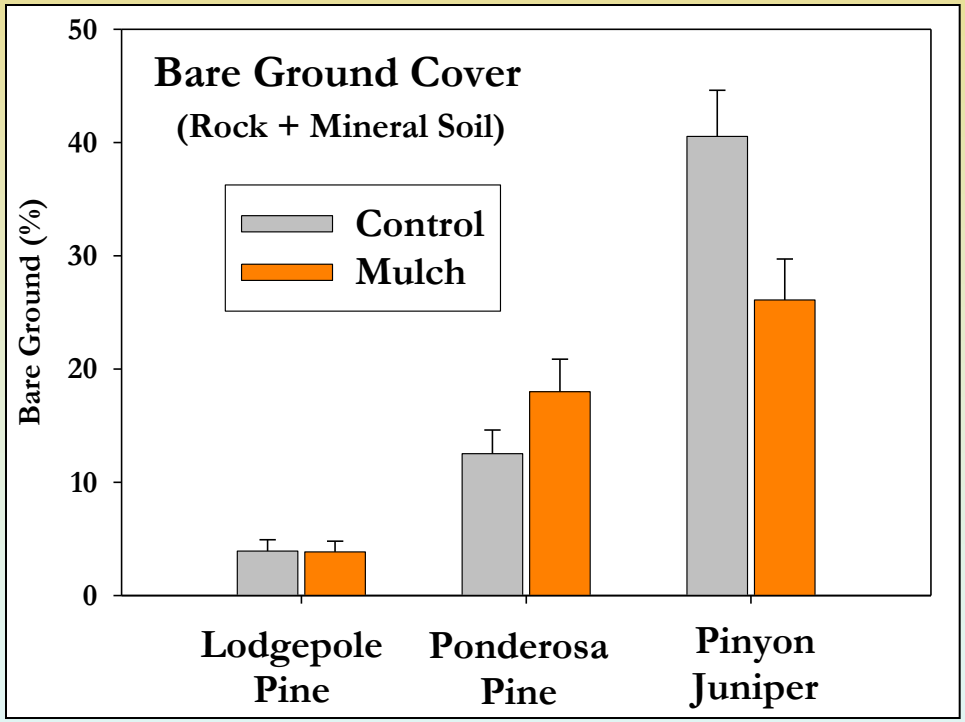
Mulch Effects –
Temperature & Moisture





Controls on Differences

- Bare Soil Cover

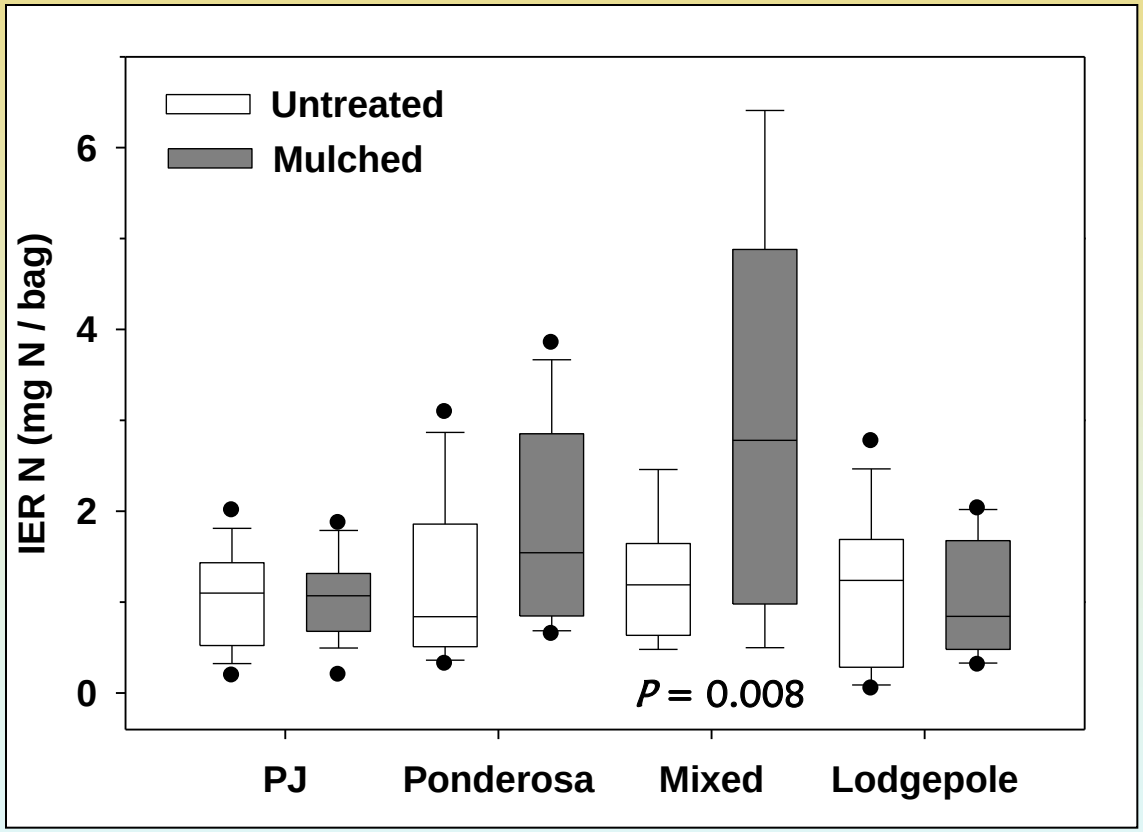


Where pre-trt bare soil cover was low (LPP) mulch had no effect

Where pre-trt bare soil cover was high (PJ), mulching created more continuous forest floor

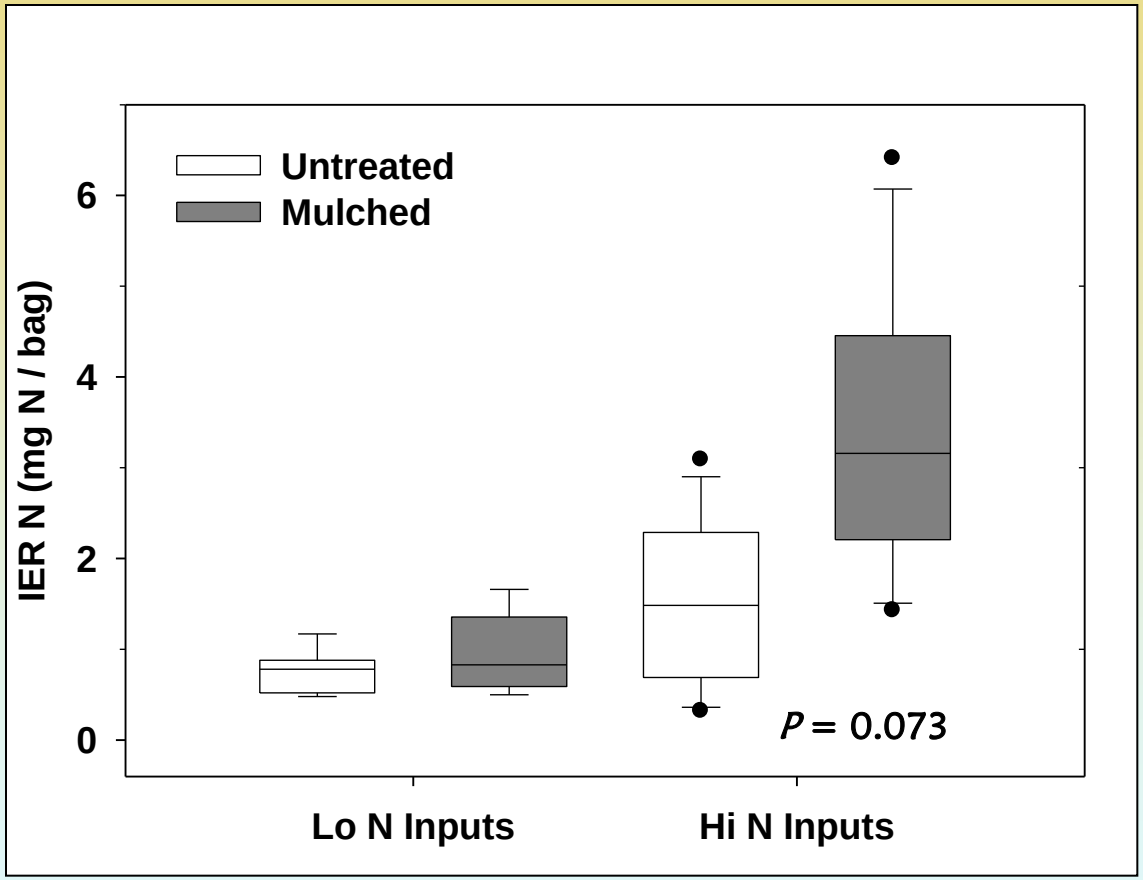
Ponderosa- Mulch increased bare soil cover

Mulch Effect on Soil N - *Transects*



- Effects Differ among ecosystems
- Mulch has no effect in PJ and LPP
- Positive Effects on Ponderosa and Mixed Conifer
- Ponderosa 1.8X increase
- Mixed Con 2.3X increase

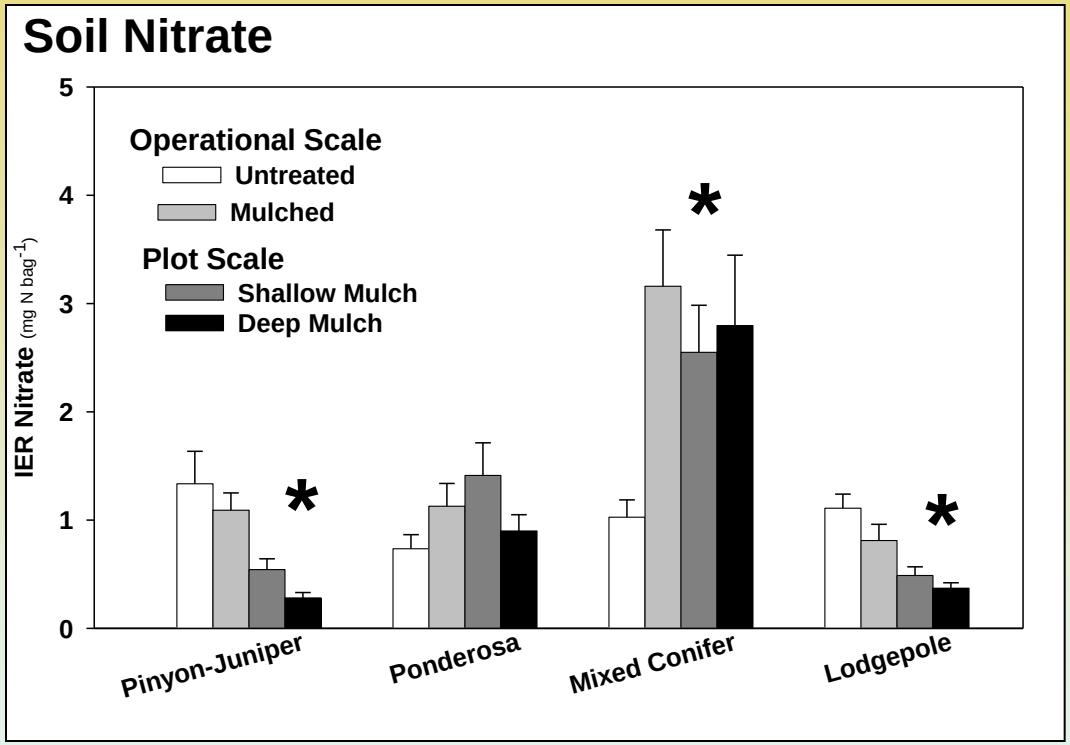
Mulch Effect on Soil N - *Transects*



Effects vary geographically as well as by Ecosystem type.

In Ponderosa & Mixed Conifer proximity to Denver Basin influences untreated and mulched soil N.

Mulch Effect on Soil N - *Depth*



Deep mulch had negative effects in some ecosystems and positive in others

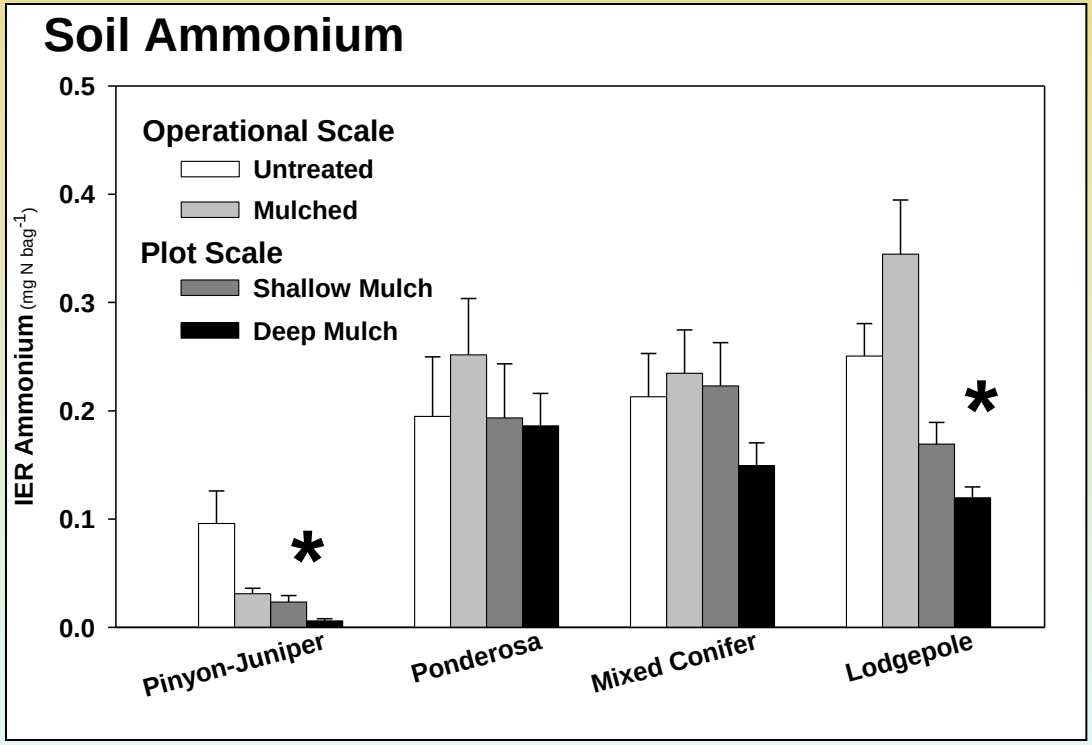
Negative mulch effects in PJ and LPP

Nitrate decreased by 79% in PJ by 67% in LPP

Under deep mulch compared to untreated areas

Deep mulch increased nitrate nearly 3-fold in mixed conifer

Mulch Effect on Soil N - *Depth*

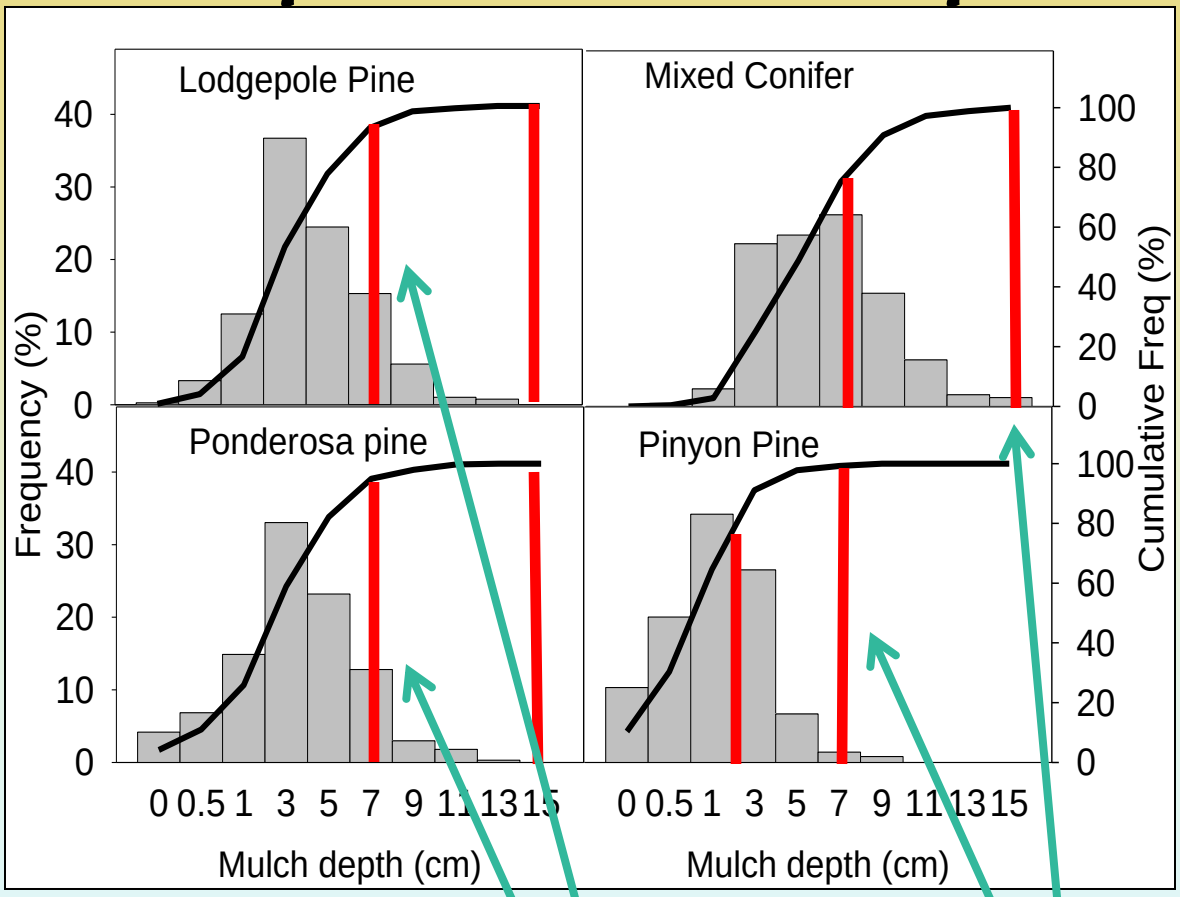


Negative mulch effects occurred in lodgepole and pinyon-juniper.

Ammonium decreased
by 94% in PJ
by 52% in LPP
… under deep mulch compared to untreated areas

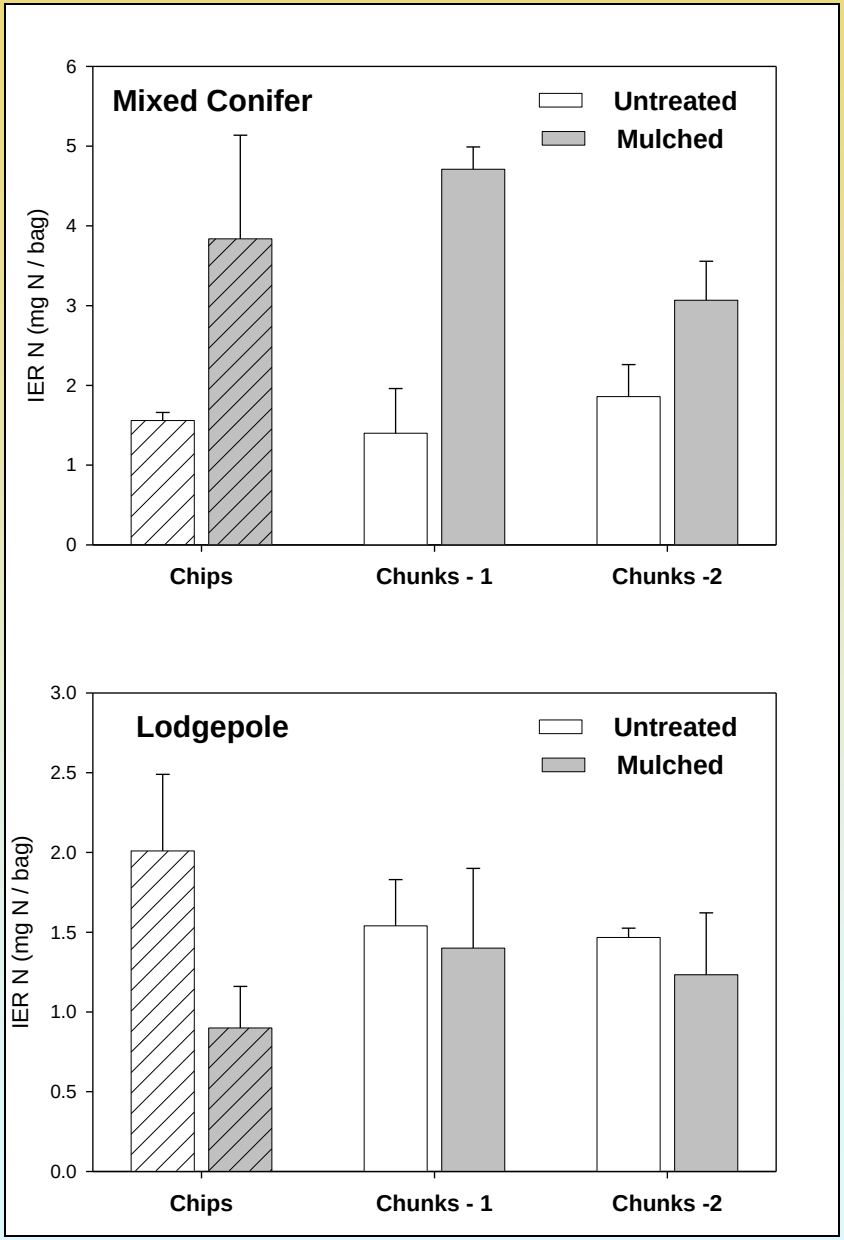
Mulch Depth

Operational vs Experimental Plots



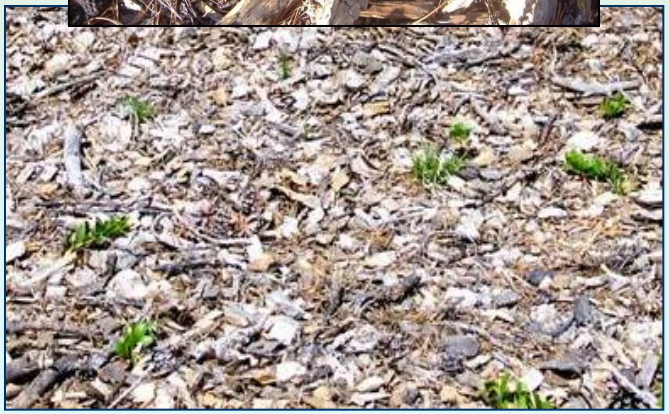
Mulched transects had ~2X deeper forest floor than controls

Mulch was rarely deeper (e.g., <20% of time) than the ***Shallow Mulch*** beds and only reached the depth of deep beds in few plots.

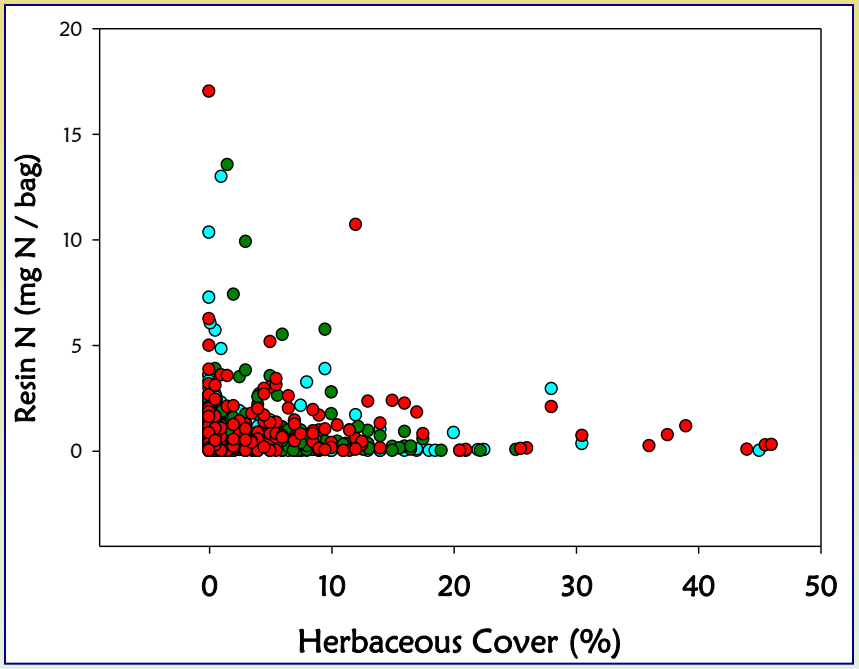


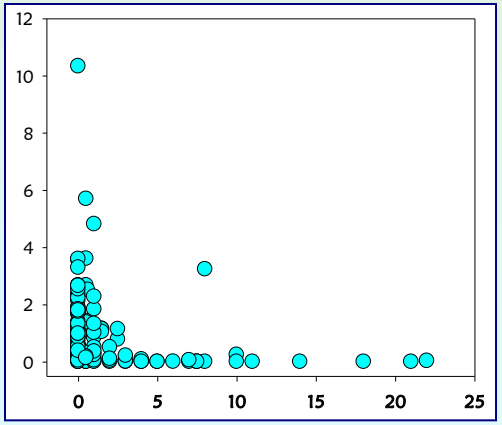
Mulch Piece Size

Within ecosystems effects were consistent between chipped and chunked



Relation with Vegetation





N availability declines with increasing grass & forb cover

N limited plants and microbes scavenging for nutrients

Effect is greatest in LPP
Lowest soil N and plant cover
Respond to light and reduce N

Take Homes

1) Mulch N inputs / Substrate quality
   - Mulch more than doubles forest floor depth and mass
   - N input is < ½ that of forest floor
     - *Mulch is a sink for soil N*

2) Effects on soil temperature & moisture
   - Cooler and wetter during growing season
   - Dampened temperature fluctuations

3) Effects on Soil N
   - Operational mulch effects are neutral or positive
   - Differ among ecosystems and regions

Take Homes

4) Threshold Mulch Depth Effect on Soil N
   - Deep mulch can have negative effects (LPP and PJ)
   - Deep mulch was rare at the operational-scale

5) Other Stuff - Site or Ecosystems Differences
   - Interaction with N deposition or site N cycling may be important. Higher N inputs could speed mulch decomposition and N release.
   - Climate Conditions / Limitations?
     - PJ is warm and dry; LPP cold
     - Pipo & Mixed Con – Moderate conditions

       may favor mulch decomposition, nutrient release

What's Next?

Lots More to Consider….

- Long-Term Effects

  Productivity, Longevity
- Biological Relevance
- Collateral Effects

  Compaction, Erosion, Leaching
- Develop, Test Management Guidelines

- _____(your idea here!)

THANKS!

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